GLOSSARY

1. Glossary

-A-

ACTIVE TIME: That time during which an item is in an operational inventory.

AFFORDABILITY: *Affordability* is a measure of how well customers can afford to purchase, operate, and maintain a product over its planned service life. *Affordability* is a function of product value and product *costs*. It is the result of a balanced design in which long-term support *costs* are considered equally with near-term development and manufacturing *cost*s.

ALIGNMENT: Performing the adjustments that are necessary to return an item to specified operation.

ALPHA (α): The probability, expressed as a decimal that a given part will fail in the identified mode. The sum of all alphas for a *component* will equal one (1).

AVAILABILITY: The instantaneous probability that a *component* will be up.

AVAILABILITY, INHERENT (A_i). The instantaneous probability that a component will be up. A_i considers only downtime for repair due to failures. No logistics delay time, preventative maintenance, etc. is included.

AVAILABILITY, OPERATIONAL (A_o). A_o is the instantaneous probability that a *component* will be up but differs from *inherent availability* in that it includes ALL *downtime*. Included is *downtime* for both corrective *maintenance* and preventative *maintenance*, including any *logistics delay time*.

-B-

BETA (β): The conditional probability that the *effect* of a *failure* mode will occur, expressed as a decimal. If a *failure* is to occur, what is the probability that the outcome will occur.

Block Diagrams: Availability block diagrams and reliability block diagrams are visual representations of the interactions between contributors to reliability, availability, and maintainability. Each block tends to represent a physical component in the system and its associated reliability/availability.

Boolean Algebra: Boolean algebra is a method of calculating system availability based on logical interactions between components. AND and OR operators define mathematical operations.

BROWNOUT: Occurs during a power *failure* when some power supply is retained, but the voltage level is below the minimum level specified for the *system*. A very dim household light is a symptom of a *brownout*.

-C-

CALIBRATION: A comparison of a measuring device with a known standard and a subsequent adjustment to eliminate any differences. Not to be confused with *alignment*.

CANNOT DUPLICATE (CND): A situation when a *failure* has been noted by the operator but cannot be duplicated by *maintenance* personnel attempting to correct the problem. Also see Retest OK.

CHECKOUT: Tests or observations of an item to determine its condition or status.

COMPENSATING PROVISION: Actions available or that can be taken to negate or reduce the effect of a *failure* on a *system*.

COMPONENT: A piece of electrical or mechanical *equipment* viewed as an entity for the purpose of *reliability* evaluation

CONDITION-BASED PM: *Maintenance* performed to assess an item's condition and performed as a result of that assessment. Some texts use terms such as *predictive maintenance* and *on-condition*. The definition of *condition-based PM* used herein includes these concepts. In summary, the objectives of *condition-based PM* are to first evaluate the condition of an item, then, based on the condition, either determine if a hidden *failure* has occurred or determine if a *failure* is imminent, and then take appropriate action. *Maintenance* that is required to correct a hidden *failure* is, of course, corrective *maintenance*.

CORRECTIVE ACTION: A documented design, process, procedure, or materials change implemented and validated to correct the cause of *failure* or design deficiency.

CORRECTIVE MAINTENANCE (CM): All actions performed as a result of *failure*, to restore an item to a specified condition. Corrective *maintenance* can include any or all of the following steps: *Localization*, *Isolation*, Disassembly, Interchange, *Reassembly*, *Alignment* and *Checkout*.

COST: The expenditure of resources (usually expressed in monetary units) necessary to develop, acquire, or use a product over some defined period of time.

CRITICALITY: A relative measure of the consequences of a *failure* mode and the frequency of its occurrence.

CRITICALITY ANALYSIS (CA): A procedure by which each potential *failure* mode is ranked according to the combined influence of *severity* and probability of occurrence.

-D-

DEPENDABILITY: A measure of the degree to which an item is operable and capable of performing its required function at any (random) time during a specified mission profile, given item *availability* at the start of the mission. (Item state during a mission includes the combined effects of the mission-related *system* R&M parameters but excludes non-mission time; see *availability*).

DETECTABLE FAILURE: *Failure*s at the *component*, *equipment*, *subsystem*, or *system* (product) level that can lie identified through periodic testing or revealed by an alarm or an indication of an anomaly.

DETECTION METHOD: The method by which a *failure* can be discovered by the *system* operator under normal *system* operation or by a *maintenance* crew carrying out a specific diagnostic action.

DIAGNOSTICS: The hardware, software, or other documented means used to determine that a malfunction has occurred and to isolate the cause of the malfunction. Also refers to "the action of detecting and isolating *failure*s or *fault*s."

DOWNTIME: That element of time during which an item is in an operational inventory but is not in condition to perform its required function.

-E-

EFFECTIVENESS: The degree to which PM can provide a quantitative indication of an impending functional *failure*, reduce the frequency with which a functional *failure* occurs, or prevent a functional *failure*.

END EFFECT: The consequence a *failure* mode has upon the operation, function or status at the highest indenture level.

EQUIPMENT: A general term designating an item or group of items capable of performing a complete function.

-F-

FAILURE (f). The termination of the ability of a *component* or *system* to perform a required function.

FAILURE, CATASTROPHIC: A *failure* that causes loss of the item, human life, or serious collateral damage to property.

FAILURE, HIDDEN: A *failure* that is not evident to the operator; that is, it is not a functional *failure*. A hidden *failure* may occur in two different ways. In the first, the item that has failed is one of two or more redundant items performing a given function. The loss of one or more of these items does not result in a loss of the function. The second way in which a hidden *failure* can occur is when the function performed by the item is normally inactive. Only when the function is eventually required will the *failure* become evident to the operator. Hidden *failure*s must be detected by *maintenance* personnel.

FAILURE, INTERMITTENT: *Failure* for a limited period of time, followed by the item's recovery of its ability to perform within specified limits without any remedial action.

FAILURE, RANDOM: A *failure*, the occurrence of which cannot be *predicted* except in a probabilistic or statistical sense.

FAILURE ANALYSIS: Subsequent to a *failure*, the logical *system*atic examination of an item, its construction, application, and documentation to identify the *failure* mode and determine the *failure* mechanism and its basic course.

FAILURE CAUSE: The physical or chemical processes, design defects, quality defects, part misapplication or other processes which are the basic reason for *failure* or which can initiate the physical process by which deterioration proceeds to *failure*.

FAILURE EFFECT: The consequence(s) a *failure* mode has on the operation, function, or status of an item. *Failure* effects are typically classified as local, next higher level, and end.

FAILURE MECHANISM: The physical, chemical, electrical, thermal or other process which results in *failure*.

FAILURE MODE: The way in which a *failure* is observed, describes the way the *failure* occurs, ie., short, open, fracture and excessive wear..

FAILURE MODE AND EFFECTS ANALYSIS (FMEA): A procedure by which each potential *failure* mode in a product (*system*) is analyzed to determine the results or effects thereof on the product and to classify each potential *failure* mode according to its *severity* or risk probability number.

FAILURE MODES, EFFECTS, AND CRITICALITY ANALYSIS (FMECA): The term is used to emphasize the classifying of *failure* modes as to their *severity* (*criticality*).

FAILURE RATE (λ): The mean (arithmetic average, also known as the forced outage rate) number of *failure*s of a *component* and/or *system* per unit exposure time. The most common unit in *reliability* analyses is hours (h).However, some industries use *failure*s per *year* (f/y) which is denoted by the symbol (λ_y).

FAILURE REPORTING AND CORRECTIVE ACTION SYSTEM (FRACAS): A closed-loop *system* for collecting, analyzing, and documenting *failure*s and recording any *corrective action* taken to eliminate or reduce the probability of future such *failure*s.

FALSE ALARM: A *fault* indicated by BIT or other monitoring circuitry where no *fault* can be found or confirmed.

FAULT: Immediate cause of *failure* (e.g., maladjustment, misalignment, defect, etc.).

FAULT DETECTION (FD): A process that discovers the existence of *fault*s.

FAULT ISOLATION (FI): The process of determining the location of a *fault* to the indenture level necessary to affect repair.

FAULT TREE ANALYSIS: An analysis approach in which each potential *system failure* is traced back to all *fault*s that could cause the *failure*. It is a top-down approach, whereas the FMEA is a bottom-up approach.

FINITE ELEMENT ANALYSIS (FEA): A modeling technique (normally a computer simulation) used to predict the material response or behavior of the device or item being modeled. FEA can describe material stresses and temperatures throughout the modeled device by simulating thermal or dynamic loading conditions. It can be used to assess mechanical *failure* mechanisms such as fatigue, rupture, creep, and buckling.

FUNCTIONAL TEST: An evaluation of a product or item while it is being operated and checked under limited conditions without the aid of its associated *equipment* in order to determine its fitness for use.

-H-

HOURS DOWNTIME PER YEAR (Hrdt/Year). Average hours the item is expected to be not functional in a one *year* period, caused by both preventative *maintenance* and *failure*s. This includes any *logistics delay time*.

-I-

INDENTURE LEVELS: The levels which identify or describe the relative complexity of an assembly or function.

ISOLATION: Determining the location of a *failure* to the extent possible, by the use of accessory *equipment*.

ITEM CRITICALITY NUMBER (Cr): A relative measure of consequence of an item *failure* and its frequency of occurrence. This factor is not applicable to a *qualitative analysis*.

-L-

LEVELS OF MAINTENANCE: The division of *maintenance*, based on different and requisite technical skill, which jobs are allocated to organizations in accordance with the availability of personnel, tools, supplies, and the time within the organization. Typical *maintenance* levels are organizational, intermediate, and depot.

LIFE CYCLE COST (LCC): The sum of acquisition, *logistics support*, operating, and retirement and phase-out expenses.

LIFE CYCLE PHASES: Identifiable stages in the life of a product from the development of the first concept to removing the product from service and disposing of it. Within the Department of Defense, four phases are formally defined: Concept Exploration; Program Definition and Risk Reduction; Engineering and Manufacturing Development; and Production, Deployment, and Operational Support. Although not defined as a phase, demilitarization and disposal is defined as those activities conducted at the end of a product's *useful life*. Within the commercial sector, various ways of dividing the life cycle into phases are used. One way of doing this is as follows: Customer Need Analysis, Design and Development, Production and Construction, Operation and *Maintenance*, and Retirement and Phase-out.

LINE REPLACEABLE UNIT (LRU): A unit designed to be removed upon *failure* from a larger entity (product or item) in the operational environment, normally at the organizational level.

LOCAL EFFECT: The consequence a *failure* mode has on the operation, function or status of the specific item being analyzed.

LOCALIZATION: Determining the location of a *failure* to the extent possible, without using accessory test *equipment*.

LOGISTIC DELAY TIME: That element of *downtime* during which no *maintenance* is being accomplished on the item because of either supply or administrative delay.

LOGISTICS SUPPORT: The materials and services required to enable the operating forces to operate, maintain, and repair the end item within the *maintenance concept* defined for that end item.

-M-

MAINTAINABILITY: The relative ease and economy of time and resources with which an item can be retained in, or restored to, a specified condition when *maintenance* is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of *maintenance* and repair. Also, the probability that an item can be retained in, or restored to, a specified condition when *maintenance* is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of *maintenance* and repair.

MAINTENANCE: All actions necessary for retaining an item in or restoring it to a specified condition.

MAINTENANCE ACTION: An element of a *maintenance* event. One or more tasks (i.e., *fault localization*, fault *isolation*, *servicing* and inspection) necessary to retain an item's condition or restore it to a specified condition.

MAINTENANCE CONCEPT: A description of the planned general scheme for *maintenance* and support of an item in the operational environment. It provides a practical basis for design, layout, and packaging of the *system* and its test *equipment*. It establishes the scope of *maintenance* responsibility for each level of *maintenance* and the personnel resources required to maintain the *system*.

MAINTENANCE DOWNTIME (Mdt). The total *downtime* for preventative *maintenance* (including *logistics delay time*, which includes spare parts availability, crew availability, etc) for a given period,Tp. (hours).

MAINTENANCE EVENT: One or more *maintenance action*s required to effect corrective and preventive *maintenance* due to any type of *failure* or malfunction, *false alarm* or scheduled *maintenance* plan.

MAINTENANCE TASK: The *maintenance* effort necessary for retaining an item in, or changing/restoring it to a specified condition.

MAINTENANCE TIME: An element of *downtime* that excludes modification and delay time.

MEAN DOWNTIME (MDT). The average *downtime* caused by preventative and corrective *maintenance*, including any *logistics delay time*. This is synonymous with mean time to restore *system* (MTTRS) as found in some publications.

MEAN TIME BETWEEN FAILURES (MTBF). The mean exposure time between consecutive *failure*s of a *component*. MTBF is a require measurement used for calculating *inherent availability*. It can be estimated by dividing the exposure time by the number of *failure*s in that period.

MEAN TIME BETWEEN MAINTENANCE (MTBM). The average time between all *maintenance* events that cause *downtime*, both preventative and corrective *maintenance*, and also includes any associated *logistics delay time***.**

MEAN TIME TO FAILURE (MTTF): The mean exposure time between consecutive repairs (or installations) of a *component* and the next *failure* of that *component*. MTTF is commonly found for non-repairable items such as fuses or bulbs, etc.

MEAN TIME TO MAINTAIN (MTTM). The average downtime for preventative maintenance. This includes any logistics delay time.

MEAN TIME TO REPAIR (MTTR). The mean time to replace or repair a failed *component*. *Logistics delay time* associated with the repair, such as parts acquisitions, crew mobilization, are not included. It can be estimated by dividing the summation of repair times by the number of repairs and, therefore, is practically the average repair time. The most common unit in *reliability* analyses is hours (h/f).

-N-

NEXT HIGHER LEVEL EFFECT: The consequence a *failure* mode has on the operation, functions, or status of the items in the next higher indenture level above the specific item being analyzed.

-O-

ON-CONDITION MAINTENANCE: See *Condition-based PM*.

ONE-LINE DIAGRAM: A one-line diagram is a drawing of an electrical or mechanical system that shows how the parts interact. It shows paths of electrical flow, water flow, gas flow, etc. It will also list system component and component sizes.

OPERATING AND SUPPORT (O&S) COSTS: Those *costs* associated with operating and supporting (i.e., using) a product after it is purchased or fielded.

OPERATIONAL READINESS: The ability of a military unit to respond to its operation plan(s) upon receipt of an operations order. (A function of assigned strength, item *availability*, status, or supply, training, etc.).

-P-

PREDICTED: That which is expected at some future time, postulated on analysis of past experience and tests.

PREDICTIVE MAINTENANCE: See *Condition-based PM*.

PREVENTATIVE MAINTENANCE (PM): All actions performed in an attempt to retain an item in a specified condition. These actions may or may not result in *downtime* for the *component*, and may or may not be performed on a fixed interval.

-Q-

QUALITATIVE ANALYSIS: A means of conducting an analysis without data. Team member subjectively rank probabilities of occurrence, typically 1-10, in place of *failure rates*.

QUANTITATIVE ANALYSIS: An analysis that is supported with data. Data is available for assigning *failure rate*s and *failure* mode probabilities.

-R-

REASSEMBLY: Assembling the items that were removed during disassembly and closing the reassembled items.

REDUNDANCY: The existence of more than one means for accomplishing a given function. Each means of accomplishing the function need not necessarily be identical.

RELIABILITY (R(t)). The probability that a *component* can perform its intended function for a specified time interval (t) under stated conditions. This calculation is based on the exponential distribution.

RELIABILITY-CENTERED MAINTENANCE (RCM): A disciplined logic or methodology used to identify preventive and corrective *maintenance task*s to realize the inherent *reliability* of *equipment* at a minimum expenditure of resources, while ensuring safe operation and use.

REPAIR DOWNTIME (Rdt). The total *downtime* for corrective *maintenance* (excluding *logistics delay time*) for a given **Tp** (hours).

REPAIR LOGISTICS TIME (Rlt). The total *logistics delay time* for corrective *maintenance* for a given **Tp** (hours).

RETEST OK (RTOK): A situation where a *failure* was detected on the *system*, either through inspection or testing, but no *fault* can be found in the item that was eventually removed for repair at a field or depot location. Also see *Cannot Duplicate*.

-S-

SECONDARY EFFECTS: The results or consequences indirectly caused by the interaction of a damage mode with a *system*, *subsystem* or *component* of the *system*.

SEVERITY: Considers the worst possible consequence of a *failure* classified by the degree of injury, property damage, *system* damage and mission loss that could occur.

SCHEDULED MAINTENANCE: Periodic prescribed inspection and/or s*ervicing* of products or items accomplished on a calendar, mileage or hours of operation basis. Included in Preventive *Maintenance*.

SERVICING: The performance of any act needed to keep an item in operating condition, (i.e. lubricating, fueling, oiling, cleaning, etc.), but not including preventive *maintenance* of parts or corrective *maintenance task*s.

SINGLE-POINT FAILURE: A *failure* of an item that causes the *system* to fail and for which no *redundancy* or alternative operational procedure exists.

SUBSYSTEM: A combination of sets, groups, etc. that performs an operational function within a product (*system*) and is a major subdivision of the product. (Example: Data processing *subsystem*, guidance *subsystem*).

SYSTEM. A group of *component*s connected or associated in a fixed configuration to perform a specified function.

SYSTEM DOWNTIME: The time interval between the commencement of work on a *system* (product) malfunction and the time when the *system* has been repaired and/or checked by the *maintenance* person, and no further *maintenance* activity is executed.

-T-

TESTABILITY: A design characteristic that allows status (operable, inoperable, or degraded) of an item to be determined and the *isolation* of *fault*s within the item to be performed in a timely manner.

TOTAL DOWNTIME EVENTS (Tde): The total number of *downtime* events (including scheduled *maintenance* and *failure*s) during the **Tp**.

TOTAL FAILURES (Tf). The total number of *failure*s during the **Tp**.

TOTAL PERIOD (Tp). The calendar time over which data for the item was collected.

TOTAL MAINTENANCE ACTIONS (Tma). The total number of preventative *maintenance action*s which take the *component* down during the Tp

TOTAL SYSTEM DOWNTIME: The time interval between the reporting of a *system* (product) malfunction and the time when the *system* has been repaired and/or checked by the *maintenance* person, and no further *maintenance* activity is executed.

-U-

UNSCHEDULED MAINTENANCE: Corrective *maintenance* performed in response to a suspected *failure*.

UPTIME: That element of *ACTIVE TIME* during which an item is in condition to perform its required functions. (Increases *availability* and *dependability*).

USEFUL LIFE: The number of life units from manufacture to when the item has an unrepairable *failure* or unacceptable *failure rate*. Also, the period of time before the *failure rate* increases due to *wearout*.

-W-

WEAROUT: The process that results in an increase of the *failure rate* or probability of *failure* as the number of life units increases.

-Y-

YEAR (y): The unit of time measurement approximately equal to 8765.81277 hours (h). Any rounding of this value will have adverse effects on analyses depending on the magnitude of that rounding. 8766 is used commonly as it is the result of rounding to 365.25×24 (which accounts for a leap year every 4th year). 8760, which is 365×24, is the most commonly used value in the power reliability field. By convention, 8760 will be used throughout this document.